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FACTS AND MENTAL SYMBOLS.

I PERCEIVE from Dr. Carus's answer to my letter in No. 3 Vol. I of *The Monist*, that amid all the agreement of our mutual endeavors a material difference of opinion exists between us on an important question of special character. As I was not successful in rendering my thought clear on this point, I shall endeavor on the present occasion to explain *what* it was that forced me to abandon my old position (1863), which is very near to that of Dr. Carus, and to assume a new one. The supposition that our difference of opinion is merely apparent and can be adjusted by a precise agreement as to the terms employed is a very natural one in philosophical discussions. It is hardly tenable, though, when the divergent views in question arise *subsequently* to one another in the *same* person.

I must state, in starting, that I pursued in my youth physical *and* philosophical studies, particularly psychology, with equal ardor. There was hardly the question at that time of an experimental psychology, of a relation of psychological to physiological research. No more so did physics at that day think of a psychological analysis of the notions it was constantly employing. How the notions of "body," "matter," "atom," etc., were come by, was not investigated. Objects were given of which physicists never questioned the inviolability and with which they unconcernedly pursued their labors.

The fields of physical and psychological research thus stood *unconciliated* the one by the side of the other, each having its own particular concepts, methods, and theories. No one questioned, in-

deed, that the two departments were connected in some way. *The way*, however, appeared an insoluble riddle; as it yet appears to Dubois-Reymond.

Now although this condition of things was not such as to satisfy my mind, it was nevertheless natural that as a student I should seek to acquire tentatively the prevailing views of both provinces and put them into consistent connection with one another.

I thus formed provisionally the view that Nature has two *sides*—a physical and a psychological side. If psychical life is to be harmonised at all with the theories of physics we are obliged, I thought, to conceive of the atoms as *feeling* (ensouled). The various dynamic phenomena of the atoms would then represent the physical processes, while the internal states *connected therewith* would be the phenomena of psychic life. If we accept in faith and seriousness the atomistic speculations of the physicists and of the early psychologists (on the unity of the soul), I still see hardly any other course to arrive at a half-way supportable monistic conception.

It is unnecessary to set forth at length here what a prominent place the artificial scaffolding we employ in the construction of our knowledge assumes in these monadic theories as contradistinguished from the facts that deserve knowledge, and how poorly such theories satisfy in the long run a vigorous mind. As a fact, employment with this cumbrous artifice was in my case the means that effected very soon the appearance of my better conviction, already latently present.*

* A Greek philosopher to whom change of spatial configuration, pressure, and percussion were probably the only natural processes of which he had any intimate knowledge, thought out the atomistic theory. This theory we retain to-day, though it be in a modified form. And in fact natural phenomena really do exist that act *as if* the pressure and impact of very small particles were involved in their production (the dynamical theory of gases), phenomena that admit therefore by this conception of being more clearly viewed. However, this conception, like that of caloric, possesses value only in certain fields. We know to-day that pressure and impact are by no means simpler phenomena than are for example the phenomena of gravitation. The contention that in physics everything can be reduced to the motion of smallest particles is, taken at its best, a more than improper draft on the future. Utterances of this kind afford no assistance to the solution of burning special questions, but only confound, and have about the same explanatory value as the utterances of the late physical philosophy of Oken which prescribe for example with the

In the further progress of my physical work I soon discovered that it was very necessary *sharply to distinguish* between what we *see* and what we mentally *supply*. When, for example, I imagine heat as a substance (a fluid) that passes from one body into another, I follow with ease the phenomena of conduction and compensation. This idea led Black, who established it, to the discovery of specific heat, of the latent heat of fusion and vaporisation, and so forth. *This same* idea of a constant quantity of heat-substance *prevented* on the other hand Black's successors from using their eyes. They no longer mark the fact which every savage knows, that heat is *produced* by friction. By the help of his undulatory theory Huygens follows with ease the phenomena of the reflexion and refraction of light. The same theory *prevents* him, for he thinks solely of the longitudinal waves with which he was familiar, from marking the fact of polarisation which he himself discovered, but which Newton on the other hand, undisturbed by theories, perceives at once. The conception of fluids acting at a distance on conductors charged with electricity facilitates our view of the behavior of the objects charged, but it *stood in the way of* the discovery of the specific inductive capacity, which was reserved for the eye of Faraday undimmed by any traditional theories.

greatest ease the course of the creation of the world by a division of zero-quantities into $+a$ and $-a$ ($0 = +a - a$).

The motion of a *single* body as a totality does indeed appear simpler at first glance than any other process, and this is the justification of attempts at a *physical* monadic theory. The thoughts of a *single* man are connected together; the thoughts of two different men are not. How can the processes of the different parts of the brain of one man be connected? In order to make the connection very intimate, we collect everything which requires to be psychically connected in a *single* point, although the connection is not explained by this procedure. Thus the psychological monadic theory is created on the basis of a motive and of an illusion similar to that on which the physical rests.

Let us assume for a moment the proposition in the text; viz., that the atoms are endowed with feeling. By the space coördinates $x, y, z, x', y', z' \dots$ of the atoms are determined *in the atoms* internal conditions $\alpha, \beta, \gamma, \alpha', \beta', \gamma' \dots$, and *vice versa*. For we feel by our senses our physical environment, and our physical invasions of our environment are conditioned by our sensations. The idea is then at hand, $\alpha \beta \gamma \dots$ alone being directly given, to set up by the elimination of $x, y, z \dots$ equations directly between $\alpha \beta \gamma, \alpha' \beta' \gamma' \dots$. This latter point of view would be very near to my present one, aside from the fact that the latter wholly rejects metaphysical considerations.

Valuable therefore as the conceptions may be which we mentally (theoretically) supply in our pursuit of facts, bringing to bear, as they do, older, richer, more general, and more familiar experiences on facts that stand alone, thus affording us a broader field of view, nevertheless, the same conceptions may, as classical examples and our own experience demonstrate, lead us astray. For a theory, indeed, always puts in the place of a fact something *different*, something more simple, which is qualified to represent it in some *certain* aspect, but for the very reason that it is different does *not* represent it in other aspects. When in the place of *light* Huygens mentally put the familiar phenomenon of *sound*, light itself appeared to him as a thing that he knew, but with respect to polarisation, which sound-waves lack, as a thing with which he was doubly unacquainted. Our theories are abstractions, which, while they place in relief that which is important for *certain fixed* cases, neglect almost necessarily, or even disguise, what is important for other cases. The law of refraction looks upon rays of light as homogeneous straight lines, and that is sufficient for the comprehension of the geometrical aspect of the matter. But the propositions that relate to refraction will never lead us to the fact that the rays of light are periodical, that they interfere. Just the contrary, the favorite and familiar conception of a ray as a smooth straight line will rather render this discovery difficult.

Only in rare cases will the resemblance between a fact and its theoretical conception extend *further* than we ourselves postulate. Then the theoretical conception may lead to the discovery of *new* facts, of which conical refraction, circular polarisation, and Hertz's electric waves furnish examples that stand in opposition to those given above. But as a general rule we have every reason to distinguish sharply between our theoretical conceptions of phenomena and that which we observe. The former must be regarded merely as auxiliary instruments that have been created for a *definite* purpose and which possess permanent value only with respect to that purpose. No one will seriously imagine for a moment that a real circle with angles and sines actually performs functions in the refraction of light. Every one, on the contrary, regards the formula

$\sin\alpha/\sin\beta = n$ as a kind of geometrical model that *imitates in form* the refraction of light and *takes its place* in our mind. In this sense, I take it, all the theoretical conceptions of physics—caloric, electricity, light-waves, molecules, atoms, and energy—must be regarded as mere helps or expedients to facilitate our viewing things. Even within the domain of physics itself the greatest care must be exercised in transferring theories from one department to another, and above all more instruction is not to be expected from a theory than from the facts themselves.

But instances were not lacking that demonstrated to me, how much greater the confusion was which was produced⁴ by the direct transference of theories, methods, and inquiries that were legitimate in physics, into the field of psychology.

Allow me to illustrate this by a few examples.

A physicist observes an image on the retina of an excised eye, notices that it is turned upside down with respect to the objects imaged, and puts to himself very naturally the question, How does a luminous point situated *at the top* come to be reflected on the retina *at the bottom*? He answers this question by the aid of dioptrical studies. If, now, this question, which is perfectly legitimate in the province of physics, be transferred to the domain of psychology, only obscurity will be produced. The question why we see the *inverted* retina-image *upright*, has no meaning as a psychological problem. The light-sensations of the separate spots of the retina are connected with sensations of locality from the very beginning, and we *name* the places that correspond to the parts down, *up*. Such a question cannot present itself to the perceiving subject.

It is the same with the well-known theory of projection. The problem of the *physicist* is, to seek the luminous object-point of a point imaged on the retina of the eye in the backward prolonged ray passing through the point of intersection of the eye. For the perceiving subject this *problem* does not exist, as the light-sensations of the retinal spots are connected from the beginning with determinate space-sensations. The entire theory of the psychological origin of the "external" world by the projection of sensations outwards is founded in my opinion on a mistaken transference of a

physically formulated inquiry into the province of *psychology*. Our sensations of sight and touch are bound up with, are connected with, various *different* sensations of space, that is to say these sensations have an existence *by the side of* one another or *outside of* one another, exist in other words in a *spatial* field, in which our body fills but a part. That table is thus self-evidently *outside of* my body. A projection-problem does not present itself, is neither consciously nor unconsciously solved.

A physicist (Mariotte) makes the discovery that a certain spot on the retina is blind. He is accustomed to associating with every spatial point an imaged point, and with every imaged point a sensation. Hence the question arises, What do we see at the points that correspond to the blind spots, and how is the gap in the image filled out? If the unfounded influence of the physicist's method of procedure on the discussion of psychological questions be excluded, it will be found that no problem exists at all here. We see *nothing* at the blind spots, the gap in the image is *not* filled out. The gap, moreover, is not felt, for the reason that a defect of light-sensation at a spot blind from the beginning can no more be perceived as a gap in the image than the blindness say of the skin of the back can be so perceived.

I have chosen intentionally simple and obvious examples, such as render it clear what unnecessary confusion is caused by the careless transference of a conception or mode of thought which is valid and serviceable in one domain, into another.

In the work of a celebrated German ethnographer I read recently the following sentence: "This tribe of people deeply degraded itself by the practise of cannibalism." By its side lay the book of an English inquirer who deals with the same subject. The latter simply puts the *question why* certain South-Sea islanders eat human beings, finds out in the course of his inquiries that our own ancestors also were once cannibals, and comes to understand the position the Hindus take in the matter—a point of view that occurred once to my five-year-old boy who while eating a piece of meat stopped suddenly shocked and cried out, "*We* are cannibals to the animals!" "Thou shalt not eat human beings" is a very beautiful

maxim; but in the mouth of the ethnographer it sullies the calm and noble lustre of unprepossession by which we so gladly discover the true inquirer. But a step further and we will say, "Man *must* not be descended from monkeys," "The earth *shall* not rotate," "Matter *ought* not everywhere to fill space," "Energy *must* be constant," and so on. I believe that our procedure differs from that just characterised only in degree and not in kind, when we transfer views reached in the province of physics with the dictum of sovereign validity into the domain of psychology, where they should be tested anew with respect to their serviceability. In such cases we are subject to dogma, if not to that which is forced upon us by a power from without like our scholastic forefathers, yet to that which we have made ourselves. And what result of research is there that could not become a dogma by long habit of use, since the very skill which we have acquired in familiar intellectual situations, deprives us of the freshness and unprepossession which are so requisite in a new situation.

Now that I have set forth in general outlines the position I take, I may be able perhaps to establish my opposition to the *dualism of feeling and motion*. This dualism is to my mind an artificial and an unnecessary one. The way it has arisen is analogous to that in which the imaginary solutions of certain mathematical problems have arisen—by the improper formulation of the questions involved.

In the investigation of purely physical processes we generally employ notions so abstract that as a rule we only think cursorily or not at all of the sensations that lie at and constitute their foundation. For example, when I establish the fact that an electric current of 1 Ampère develops $10\frac{1}{2}$ cubic centimetres oxyhydrogen gas at 0° C. and 760 mm mercury pressure in a minute, I am easily disposed to attribute to the objects defined a reality wholly independent of my sensations. But I am obliged in order to arrive at what I have determined to conduct the current through a circular wire having a definite measured radius, so that the current, the intensity of terrestrial magnetism being given, shall turn the magnetic needle at its centre a certain angular distance out of the meridian. The intensity of terrestrial magnetism must have been disclosed by a definite

observed period of vibration of a magnetic needle of measured dimensions, known weight, and so forth. The determination of the oxyhydrogen gas is no less intricate. The whole statement, so simple in its appearance, is based upon an almost unending series of simple sensory observations (sensations), particularly so when the observations are added that guarantee the adjustment of the apparatus, which may have been performed in part long before the actual experiment. Now it may easily happen to the physicist who does not study the psychology of his operations, that he does not (to reverse a well-known saying) see the trees for the woods, and that he slurs over the sensory elements at the foundation of his work. Now I maintain, that every physical notion is nothing more than a definite connection of the sensory *elements* which I denote by $A B C . . .$, and that every physical fact rests therefore on such a connection. These *elements*—elements in the sense that no further resolution has for the present been effected of them—are the most ultimate building stones of the physical world that we have as yet been able to seize.

Physiological research also may have a purely physical character. I can follow the course of a physical process as it propagates itself through a sensitive nerve to the spinal column and brain of an animal and returns by various paths to the muscles of the animal, whose contraction produces further events in the environment of the animal. I need not think, in so doing, of any feeling on the part of the animal; what I investigate is a purely physical object. Very much is lacking, it is true, to our complete comprehension of the details of this process, and the assurance that it is all motion can neither console me nor deceive me with respect to my ignorance.

Long before there was any scientific physiology people perceived that the behavior of an animal confronted by physical influences is much better viewed, that is understood, by attributing to the animal *sensations* like our own. To that which I see, to *my* sensations, I have to *supply mentally* the sensations of the *animal*, which are not to be found in the province of my own sensation. This contrariety appears still more abrupt to the scientific inquirer who is investigating a nervous process by the aid of colorless abstract notions, and is required for example to add mentally to that process

the sensation green. This last can actually appear as something entirely novel, and we can ask ourselves how it is that this miraculous thing is produced from chemical processes, electrical currents, and the like.*

Psychological analysis has taught us that this surprise is unjustified, since the physicist deals with sensations in everything on which he employs himself. This analysis is also able to render it clear to us that the mental addition by analogy of sensations and complexes of sensations which at the time being are not present in the field of sense or cannot even come into it, is also daily practised by the physicist, as when for example he imagines the moon an inert heavy mass although he cannot touch the moon but only see it. The totally strange character of the intellectual situation above described is therefore an illusion.

The illusion disappears when I make observations (psychologically) on my own person which are limited to the sensory sphere. Before me lies the leaf of a plant. The green (*A*) of the leaf is united with a certain optical sensation of space (*B*) and sensation of touch (*C*), with the visibility of the sun or the lamp (*D*). If the yellow (*E*) of a sodium flame takes the place of the sun, the green (*A*) will pass into brown (*F*). If the chlorophyl granules be removed,—an operation representable like the preceding one by elements,—the green (*A*) will pass into white (*G*). All these observations are *physical* observations. But the green (*A*) is also united with a certain process on my retina. There is nothing to prevent me in

* The following is a legitimate question : To what kind of nervous processes is the sensation green to be mentally added. Such questions can be solved only by special inquiry, and not by a reference in a general way to motion and electric currents. How disadvantageous our remaining satisfied with such general conceptions is, can be seen from the fact that inquirers have been repeatedly on the brink of abandoning the *specific energies*, one of the greatest acquisitions we have made, simply because they were unable to discover any difference in the currents of different sensory nerves. I was impelled as early as 1863 in my lectures on psychophysics to call attention to the fact that the *most diverse kinds* of nervous processes can conceal themselves in a current. Current is an abstraction and places in relief but one feature of the process—the passage of energy through a transverse section. A current in diluted sulphuric acid is something entirely different from a current in copper. We must therefore also expect that a current in the acoustic nerve is something entirely different from a current in the optic nerve.

principle from physically investigating this process on my own eye in exactly the same manner as in the cases previously set forth, and from reducing it to its elements $X Y Z . . .$ If this were not possible in the case of my own eye, it might be accomplished with that of another, and the gap filled out by analogy exactly as in physical investigations. Now in its dependence upon $B C D . . .$, A is a *physical element*, in its dependence on $X Y Z . . .$ it is a *sensation*. The green (A) however is not altered at all *in itself*, whether we direct our attention to the one or to the other form of dependence. *I see, therefore, no opposition of physical and psychical, no duality, but simply identity.* In the sensory sphere of my consciousness everything is at once physical and psychical.

The obscurity of this intellectual situation has arisen according to my conviction solely from the transference of a physical prepossession into the domain of psychology. The physicist says: I find everywhere bodies and the motions of bodies only, no sensations; sensation therefore must be something *entirely different* from the physical objects I deal with. The psychologist accepts the second portion of this declaration. To him, it is true, sensation is *given*, but there corresponds to it a mysterious physical something which conformably to physical prepossession must be *different* from sensation. But what is it that is the really mysterious thing? Is it the Physis or the Psyche? or is it perhaps *both*? It would almost appear so, as it is now the one and now the other that is intangible. Or does the whole reasoning involved rest on a fallacious circle?

I believe that the latter is the case. For me the elements designated by $A B C . . .$ are immediately and indubitably given, and for me they can never afterwards be volatilised away by any considerations which are after all based in every case on their existence.*

*It is the transitoriness of sense-perceptions that so easily leads us to regard them as mere appearances as contrasted with permanent bodies. I have repeatedly pointed out that unconditioned permanent states do not exist in nature, that permanences of connection only exist. A body is for me the same complex of sight-and-touch-sensations every time that it is placed in the same circumstances of illumination, position in space, temperature, and so forth. The supposed constancy of the body is the constancy of the union of $A, B, C . . .$ or the constancy of the *equation* $f(A, B, C . . .) = 0$.

To the department of special research having for its subject the sensory, physical, and psychical province which is not made superfluous by this general orientation and which cannot be forestalled, the relations of $A B C \dots$ only remain to be ascertained. This may be expressed symbolically by saying that it is the purpose and end of special research to find equations of the form $f(A, B, C, \dots) = 0$.

I hope with this to have designated the point in which I am in opposition to Dr. Carus, with whom I agree so much in other respects. I am obliged, notwithstanding the latter fact, to regard this point as essential, inasmuch as my whole mode of thinking and direction of inquiry have been changed by the view it involves, and because, moreover, I do not believe that the difference in question can be dissipated by any verbal explanations however exact.

This whole train of reasoning has for me simply the significance of negative orientation for the avoidance of pseudo-problems. I restrict myself, moreover intentionally here, to the question of sense-perceptions, for the reason that at the start exact special research will find here alone a safe basis of operations.

ERNST MACH.